Water Quality Improvement in Stage 1
Operations, Impacts and Solutions
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Problem Statement

Water quality in the Delta can be affected by operational changes in a number of ways, with subsequent impacts on fisheries and water users. For example, increased flows and decreased exports in the spring for the protection of fisheries can result in decreased fall flows (since the reservoir releases that would have been made in the fall are made in the spring) and increased exports in the fall (because water that would have been exported in the spring is instead delivered from south of Delta storage and those reservoirs are refilled in the fall). The result in this case is increased salinity intrusion and worsened water quality in the fall which can lead to changes in the location of fish and impacts to reservoir water quality and water users.

CALFED is proposing some source water quality measures; some of these (such as drainage management) are included in the discussion below as they are related to mitigation measures that may provide mitigation or help with continuous improvement. Many, however, are pilot programs and are not likely to provide for significant improvement in Stage 1. With the exception of drainage management in Rock Slough, Barker Slough and Old River, none deal with bromide issues for urban agencies (and even those are limited in bromide benefits) and none of the pilot programs (which constitute nearly all the rest of the program) provide significant improvement in Stage 1. The extent these programs provide improvement should be considered in the overall program.

The impacts should be considered in terms of those impacted, when they are impacted and the degree to which they are impacted. For example, the worst water quality in the Delta is consistently in the fall and early winter. This affects Central and South Delta agriculture (particularly Central) in crops grown in that period, urban users and export agriculture users (directly and later from stored water). Spring impacts affect primarily Delta agricultural users since most other users are limited in diversions in that period. Most operational measures were identified as not adversely affecting water quality in a way that impacts fisheries in the Delta, but there may be impacts in the San Joaquin River upstream of the Delta, as decreased flows that result in some times may result in worse water quality in those reaches.

Impacts can occur from a variety of actions. Increased flows in the spring, when water quality is already good, do not usually result in significant changes in water quality in the Delta interior (since there is little, if any, salinity intrusion into the Delta); however, the water expended can later reduce flows in the fall, when there is significant salinity intrusion, exacerbating an already serious problem. Decreased pumping can affect water quality in the south Delta. High pumping draws water from the Sacramento River to the south Delta and mixes with water in the south Delta; this action improves water quality because the movement of high quality water into the south Delta dilutes drainage that comes from the Delta and the San Joaquin River. Reduced exports then result in degraded water quality when this dilution is reduced or eliminated and the south Delta starts to fill with local drainage and San Joaquin River water.

Cross-channel closures, which are proposed here for fishery protection as opposed to flood protection, can result in degraded water quality locally under any conditions and over a widespread region during periods of low outflow when salinity has already moved well into the western Delta; however, both can be difficult to quantify accurately. Local degradation depends on the local drainage and lack of circulation. Increased salinity during low outflow periods is difficult to quantify because there are few data: historically, nearly all cross-channel closures occurred when outflow was high and therefore salinity levels were low; consequently the impacts of altered flow patterns are not easily discernible in the salinity data. Note that cross-channel closures can, when water quality is affected, represent a trade-off between water quality and fishery protection.

There are two exceptions when the cross-channel was closed during low flows: in 1977 and 1997. In 1977 the cross-channel was half-closed for more than a month in an attempt to improve water quality at Emmaton (closing the cross-channel has an almost immediate impact on salinity at Emmaton, as more water moves down the Sacramento River and freshens that area). Jersey Point salinity did not appear to change during this period relative to Chipps Island, but it was a short period and the cross-channel was only half-closed.

In 1997, the cross-channel was closed in the fall for about two weeks. Emmaton salinity dropped, and Jersey Point salinity rose, but the Delta was filling due to tides during that period and other stations (such as Chipps Island) were also rising. It was clear the response at Jersey Point was not the same as usual and was probably higher or responding to flow changes more slowly, so that it stayed higher for a longer period, but the degree to which it changed was not clear because the test lasted only two weeks. Whether the interior Delta salinity changed is not clear; there is a direct relationship between the salinity at Rock Slough and Jersey Point, with about a two-week lag, so that no response was seen at Rock Slough. [Note that models are of somewhat limited use, since they are calibrated to historical data; the G-model has not been calibrated for this effect at Jersey Point, although the model has been for Emmaton, where the effect of the cross channel is very noticeable. Data analysis of the Fischer Delta Model (FDM) demonstrates that the model overstates the effect, (i.e., under these conditions the model overstates salinity at Rock Slough); DSM2 also appears to overstate the effect as the Rock Slough salinity from DSM2 is sometimes very high compared to historical levels. However, both the FDM and DSM2 do show an effect, especially at low outflow and high exports. Note also there are no data when the cross channel is closed with maximum pumping at Banks: this condition has never been seen in the Delta.]

Examples of Water Quality Impacts

Under the Accord, chloride at Rock Slough is typically in the 130 mg/l to 200 mg/l range in the fall of all but the wettest years (for example, all but 1995 and 1998 recently, but these levels were reached in the fall of wet years of 1996 and 1997). In 1997, it was exacerbated by the AFRP actions, which shifted pumping to the fall and reduced fall flows, causing salinity to rise sooner and to higher levels. An example is seen in the attached figure of simulated Rock Slough salinity, which shows the effects of the AFRP and other fishery protection actions (combined in some cases with water supply measures) with higher salinity levels in the spring of 1984 (a wet year) and in the fall of most other years. In the spring, the cause is reduced dilution of drainage and San Joaquin River water, and this affects primarily Delta agriculture, since most others are at reduced pumping levels at that time. However, the increase in salinity results in increased drainage salinity later. In the fall, it exacerbates salinity intrusion from Suisun Bay, and is a combined effect of higher pumping, lower outflow and cross-channel closures. The low outflows result in salinity intrusion and if it is severe enough the salinity can be redistributed because of cross-channel closures and increased pumping. (In the fall the effect is due to increased pumping and decreased flows that resulted from the required increased flows and decreased pumping in the spring, and in the spring it is due to decreased spring pumping which results in lower dilution of drainage and San Joaquin flows—a double hit.)

In dry years, decreased flows and increased pumping in the fall may result in two impacts: higher levels of salinity intrusion appearing sooner than would have occurred had there been no pumping shift and increased upstream releases to avoid exceeding water quality standards (in the latter case, the salinity is near the standard and water quality is unchanged, but more flow is needed to maintain it). For example, in the attached figures, the AFRP actions are more balanced in the fall of dry periods because they result in relatively small changes, but the A-1 cases show dramatic increases in salinity. The bar graph (figure 6) indicates one significant cause: the shift in pumping from spring to summer and fall that results from the fish protection actions. The other is cross-channel closures in the fall. These appear to primarily affect water quality in the late fall and early winter, although some impacts are seen in November of some years.

Although improved water quality can also result, the actions proposed to date show few periods when this occurs, and they are more modest improvements. Most of the improvements discernible in the attached graphs are associated with the Hood diversion. Some of these are due to increased outflows required to meet Rio Vista flows and may not occur if the diversion is not operated when Rio Vista flows are controlling. The improvements are on the order of 50 to 100 mg/l TDS (25 to 50 mg/l chlorides) and occur primarily in the fall. There are other periods, however, which show similar levels of degradation.

The reason there are few improvements in water quality from the measures proposed is that most of the proposed export reductions are in periods when drainage and San Joaquin flows can dominate (and therefore water quality is not improved), and most outflow increases occur when there is little or no salinity intrusion; conversely, most export increases and outflow reductions occur when there is already significant salinity intrusion.

Note that there can be water quality changes due simply to water quality measures, such as JPOD and the expansion of Banks pumping plant, as well as increased storage. This may affect the level and timing of water quality impacts and the degree of mitigation or improvement necessary for water quality.

Magnitude and extent of water quality impacts

The attached figures indicate the magnitude and extent of the problem. There are a number of periods where potential actions can raise salinity levels by as much as 300 mg/l TDS (150 mg/l chloride), an increase of 50% or more at Rock Slough and Clifton Court, affecting in-Delta users and exporters alike. In other cases, salinity levels rise from about 200 mg/l TDS to 250 mg/l TDS (a 25 mg/l chloride rise). These periods last for several months at a time in the fall and early winter and can have a significant impact on urban water quality and for central and south Delta agriculture. To the extent the water in this period is diverted to San Luis Reservoir, it can also impact water quality to export agriculture and in turn the water quality in the San Joaquin River.

Increases in the spring are generally small (less than 100 mg/l TDS) and these will affect in-Delta users (CCWD when it is diverting and Delta agriculture).

At many other times, water quality is unchanged by the proposed actions, and in some cases there are improvements in water quality of a significant level. However, the studies show these are much less frequent and of smaller magnitude than the degradation that occurs.

	Delta Ag	Delta Urban	Export Ag	Export Urban
Spring	Impacted during VAMP period. Related to low exports and drainage. Impacts reduced if San Joaquin salt load reduced or exports increased. Can affect drainage later. Increases are up to 100 mg/l TDS	Impacted during VAMP period. Related to low exports and drainage. Impacts reduced if San Joaquin salt load reduced or Delta drainage reduced. Increases are up to 100 mg/l TDS. Impacts depend on diversion levels.	Exports limited	Exports limited
Summer	Impacted by SJR water quality, resulting from VAMP.	Impacted by SJR water quality, resulting from VAMP, when barriers operational.	Impacted by SJR water quality, resulting from VAMP. Can in turn increase salt load to SJR. Reduced if barriers operational	Impacted somewhat by SJR water quality, resulting from VAMP. Can in turn increase salt load to SJR. Reduced if barriers operational
Fall	Central and south Delta impacted by water quality increases in fall from operational changes.	Most severe impacts in fall because water quality is already poor.	Most severe impacts in fall because water quality is already poor.	Most severe impacts in fall because water quality is already poor in dry years.
Winter	Central and south Delta impacted by water quality increases in winter from ops changes	Most severe impacts in winter because water quality is already poor.	Most severe impacts in winter because water quality is already poor.	Most severe impacts in winter because water quality is already poor in dry years.

Mitigation Measures for Water Quality

There are several measures that can be taken to ensure that there is a continuous improvement in water quality for all Delta users. These are: 1) mitigation measures to better manage drainage, 2) operations to offset impacts of cross-channel closures, 3) increased outflow for the purpose of reducing salinity intrusion, 4) provision of better water quality through operational measures (operating for water quality), 5) water exchanges, and 6) south Delta improvements linked to other planned measures.

1. Drainage management. A number of CALFED actions have been identified to manage drainage to improve water quality. These include redirecting drainage close to intakes (Rock Slough, Old River and others), managing drainage so that it is discharged when it has a smaller impact (holding for ebb tide in the Delta or high flows in the San Joaquin River, or short term land use changes in the Delta) and re-use or treatment (wetlands creation). All are planned on pilot or higher levels in the CALFED program and can be beneficial for all users, but are focused on local problems. For Rock Slough, winter and early spring chloride levels can be improved by as much as 100 mg/l and perhaps by 5 mg/l in other periods. However, the largest improvements come when most diversions are made at the Old River intake. For Old River, Clifton Court or California Aqueduct drainage, improvements may be primarily in potential pathogens and TDS, not bromide or chloride, since chloride and bromide are a smaller fraction of diversions. Note that if water quality that is applied to agricultural lands is improved, the resulting drainage salt load is reduced.
2. Operations to offset cross-channel closures. These can include the Hood diversion (or screened Sacramento diversion north of Hood), periodic openings of the cross-channel to control water quality and increased outflow when the cross-channel is closed during periods of salinity intrusion. Periodic openings of the cross-channel may mitigate any impacts but may also affect fishery protection measures. This might include some water quality triggers for opening the cross-channel gates. Note that the increased outflow will be forced when the Delta is operated to a salinity standard in the south Delta (i.e., when Jersey Point, Antioch or Rock Slough salinity standards control operations). In this case, there will be a water cost which must be estimated to determine the "charge" against whatever account is used for this purpose (EWA or other Stage 1 measures). It may be desirable to experimentally determine this cost (using sensitivity tests covering a month or more where incremental changes in outflow or exports are made, or the cross-channel gates are opened).
3. Increased outflow to reduce salinity intrusion. Water could be used to improve water quality in the fall. Where the water comes from could be linked to phasing in Stage 1 and could be shared with the other two legs of the stool (supply and environment). This measure would provide benefits to all users and could be phased in or out depending on other measures to provide continuous improvement in water quality.. To the extent it is direct mitigation for environmental actions, it could be charged to the EWA, but the degree is a policy issue. If used over three or four months in the late summer or fall, this water could reduce chloride levels 50 mg/l or more at Rock Slough and Clifton

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Court for a significant period. This would improve water quality in the south Delta, offsetting impacts of the VAMP on south Delta users, improve water quality going to exporters and improve water quality stored in San Luis Reservoir. Improvements in water quality to San Luis Reservoir would reduce the salt load to the San Joaquin River.

4. Operational measures. These include operating to improve water quality (such as diverting water during the spring when water quality is high). These may be more difficult to implement because they can be at odds with fishery goals. Water diverted to storage during high quality periods will help exporters (although these periods tend to occur in the spring and summer). EWA actions may cause this, since they may shift in some years pumping out of the fall when water quality is poor to wetter periods in the winter when it may be better. When accounting for impacts, the timing of use with water quality changes needs to be taken into account. Splitting the DMC and California Aqueduct at the O'Neill Forebay could help all export users by filling San Luis Reservoir with higher quality water and keeping DMC water separate from SWP water (however, this may result in degradation of San Joaquin River water quality). These measures primarily help exporters and do not improve water quality for in-Delta users; if coupled with measures such as recirculation or moving the improved water from San Luis to ag users, it could help water quality in the San Joaquin River and thus Delta water quality..
5. Water exchanges. A number have been proposed. However, they help only selected users and do not improve water quality for other Delta users. There are two exchanges that may significantly improve water quality for urban users. The first is a Friant-MWD exchange, whereby SWP water is provided to Friant users in exchange for Friant water which is delivered to MWD. The second is a Bay Area exchange in which EBMUD, CCWD, SCVWD and Alameda-Zone 7 participate. Using the EBMUD current and proposed aqueducts, high flows from the Mokelumne and American Rivers would be delivered to the other agencies, via a Los Vaqueros Reservoir sized for providing water quality to these Bay Area urban agencies with an improvement in water quality for the participants.
6. South Delta improvements. The central Delta intake, using, for example a screened intake with water coming from Middle River directed through Trapper Slough, Whiskey Slough and Victoria Canal, could provide better water quality for Delta users. It could be coupled with Delta island storage or an enlarged CCFB. Water would be provided to some local users on Upper and Lower Jones Tract, Union Island, and Roberts Island (providing screened water of improved quality) and to the export pumps. It may be limited in capacity (or designed as a test facility with a small capacity but with increased capacity possible if it works). It provides an additional intake that can be managed for water quality or fishery protection and provides benefits fish and water users. It may result in degraded water quality in the far south Delta, but may also help with water levels. It can be incorporated with other south Delta improvements such as the barriers, to allow full use of Banks capacity (note that it can move a significant portion of the export flow out of the south Delta, thus improving water levels). South Delta improvements are being discussed in another forum, but it is assumed they will play a role in the overall picture.

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Policy Issue Bin

Who pays the water costs if continuous improvement in water quality requires water?

If an environmental action has a water quality impact, how is it remedied and who pays? Is it shared from new water development with supply and the environment? How are these things phased?

What is continuous improvement in water quality for the south Delta? Is it measured from standards, which are not met now or from planned operations now? How can standards be attained? Where standards are met, should continuous improvement focus on periods where water quality is worst and beneficial uses most affected?

What improvement can be made through CALFED in San Joaquin River water quality through source control? How will this feedback to the salt load in the valley and what improvements result?

What improvement can be made through CALFED in wastewater treatment plants improvements for urban water quality? Can discharges be reduced through recycling or better treatment of discharges potentially affecting urban intakes?

How should the cross-channel be operated to meet fisheries goals and avoid water quality impacts?

How are improvements to be phased?